

NEW SPECIES OF NEARCTIC *NEOPERLA* (PLECOPTERA: PERLIDAE),
WITH NOTES ON THE GENUS

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ABSTRACT.—The Nearctic *Neoperla* are reviewed. Eight species, placed in two nominal groups, are recognized. *Neoperla carlsoni*, new species, *N. catharae*, new species, *N. choctaw*, new species, *N. freytagi*, new species, *N. gaufini*, new species, and *N. stewarti*, new species, are described for male, female, and egg. Male holotypes and female allotypes are designated for each species. *Neoperla mainensis* Banks and *N. clymene* (Newman) are redescribed and *mainensis* is raised to species. Descriptions are supported by original drawings and stereoscan photomicrographs. Relationships of Nearctic species groups to the world fauna are discussed.

Needham and Claassen (1925) established the concept of *Neoperla clymene* (Newman) as a widespread, variable species. Frison (1935) accepted this usage, and Hynes (1952) and Ricker (1952) reiterated variability of the species.

Recent studies of Ethiopian *Neoperla* (Zwick 1973a,b) suggest the need for critical examination of Nearctic populations of the genus. Preliminary results, from material at hand, indicate a minimum of eight species in the complex. Descriptions of these are presented herein.

Neoperla carlsoni, n. sp.

Figs. 1, 2, 3, 4, 5, 65, 66

Neoperla sp. A: Stewart, Stark & Huggins, 1976:378.

MALE.—Macropterous. Length of forewings 5–7 mm; length of body 5–7 mm. Dorsum of head yellow with brown markings on anterior region of frons. Pronotum brown with darker rugosities and sutures, a narrow pale stripe extending along median suture. Tibiae, tarsi, and apical half of femora dark brown. Wings amber, veins brown; coastal margin pale yellow. Process of tergum 7 slender, ventrally spinulose, extending to near posterior margin of tergum 8. Process of tergum 8 abruptly elevated on posterior margin, slightly spinulose. Spinules absent from membrane of tergum 8. Mesal spinule patch of tergum 9 with 6–10 spinules, lateral patches absent. Shaft of aedeagus with external spines arranged in two

ventral groups; left grouping with 25–35 spines, right grouping with 5–8 spines. Extrusible, apical section of aedeagus heavily spiculate and armed basally with scattered spines.

FEMALE.—Macropterous. Length of forewings 8–10 mm; length of body 8–10 mm. Color pattern similar to male. Subgenital plate slightly produced, posterior margin rounded and slightly notched. Vagina without sclerites; spermatheca short and completely lined with golden-brown spinulae in basal half.

ECC.—Outline oval, cross section circular. Collar distinctly stalked. Chorion uniformly, finely punctate.

TYPES.—Holotype (♂) and allotype (♀) from Rocky Comfort Creek, 7 mi S Quincy, Gadsden Co., Florida, 16-IV-1967, W. L. & J. G. Peters. Holotype, # 73355, and allotype deposited at the U.S. National Museum. Paratypes: FLORIDA: *Gadsden Co.*, Rocky Comfort Creek, 10-VI-1970, W. L. Peters, et al., 3 ♂ 1 ♀ (BPS); same data, 10-VIII-1967, G. Cooper, et al., 1 ♂ (FAM). *Okaloosa Co.*, Blackwater River, 8-V-1972, W. L. Peters, et al., 1 ♀ (FAM). *Santa Rosa Co.*, Blackwater River, Riley Landing, 7-VIII-1971, W. L. Peters, et al., 2 ♂ (FAM). *Walton Co.*, Alaqua Creek, 21-VI-1971, P. H. Carlson, et al., 3 ♂ (PHC). LOUISIANA: *Grant Par.*, Pollock, 24-VII-1967, E. A. Cancienne, 1 ♂ (NTSU). *Livingston Par.*, Little Natalbany River, Albany, 27-VI-1973, B. Stark, 1 ♂ 3 ♀ (BPS).

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Vernon Par., Fort Polk, 18-VI-1968, L. D. Newson, 2 ♂ (NTSU). OKLAHOMA: *McCurtain Co.*, Battiest, 14-VI-1972, D. C. Arnold, 3 ♀ (NTSU). SOUTH CAROLINA: *Aiken Co.*, Three Runs Creek, 21-VII-1971, J. W. Richardson, 2 ♀ (BPS). TEXAS: *Anderson Co.*, Salmon, 7-27-VI-1975, H. R. Burke, 8 ♂ 4 ♀ (TAM) (NTSU). *Nacogdoches Co.*, Nacogdoches, 10-VI-1969, R. Dorman, 1 ♂ 1 ♀ (NTSU).

ETYMOLOGY.—This species is named in honor of Mr. Paul Carlson who has made available for our study a large number of Plecoptera specimens from the southeastern United States.

Neoperla catharae, n. sp.

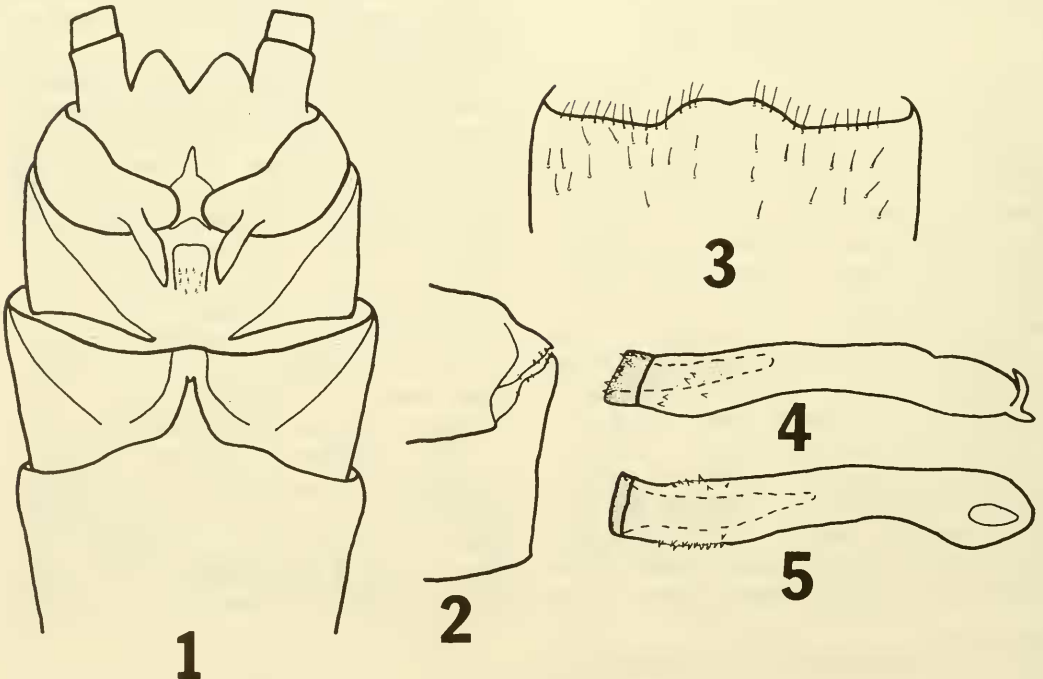
Figs. 6, 7, 8, 9, 64

MALE.—Macropterous. Length of forewings 5–7 mm; length of body 5–7 mm. Dorsum of head yellow with brown markings on anterior region of frons. Pronotum brown with darker rugosities and sutures. Tibiae, tarsi and apical half of femora dark

brown. Wings amber, veins brown; coastal margin pale yellow. Process of tergum 7 slender, ventrally spinulose, extending to near posterior margin of tergum 8. Process of tergum 8 abruptly elevated on posterior margin, slightly spinulose. Spinules absent from membrane of tergum 8. Mesal spinule patch of tergum 9 with 6–10 spinules, lateral patches with a few scattered spinules. Shaft of aedeagus with external spines arranged in two ventral groups; left grouping with 5–12 spines, right grouping with 12–20 spines. Extrusible, apical section of aedeagus heavily spiculate and armed basally with several scattered spines.

FEMALE.—Macropterous. Length of forewings 8–10 mm; length of body 8–10 mm. Color pattern similar to male. Subgenital plate slightly produced, posterior margin smoothly rounded to slightly notched. Vagina without sclerites; spermatheca short and completely lined with golden-brown spinulae in basal half.

Egg.—Outline oval, cross section circular. Collar distinctly stalked. Chorion smooth.



Figs. 1–5. *Neoperla carlsoni*: 1, Male terminalia, dorsal; 2, Male terga, 7 and 8, lateral; 3, Female sternum 8; 4, Aedeagus, lateral; 5, Aedeagus, ventral.

TYPES.— Holotype (♂), allotype (♀), and 11 ♀ paratypes from James Creek, Randolph Co., Arkansas, IX-1969, M. Case. Holotype, #73357, and allotype deposited at the U.S. National Museum. Paratypes: ARKANSAS: *Washington Co.*, Cove Creek, 4-VIII-1962, 4 ♀ (INHS). OHIO: *Butler Co.*, Oxford, 30-VI-1902, 1 ♂ (UU). *Warren Co.*, Todds Fork, Morrow, 15-VIII-1951, A. R. Gaufin, 2 ♂ 3 ♀ (UU) (BPS); same data, 5-VIII-1953, 7 ♀ (UU) (BPS).

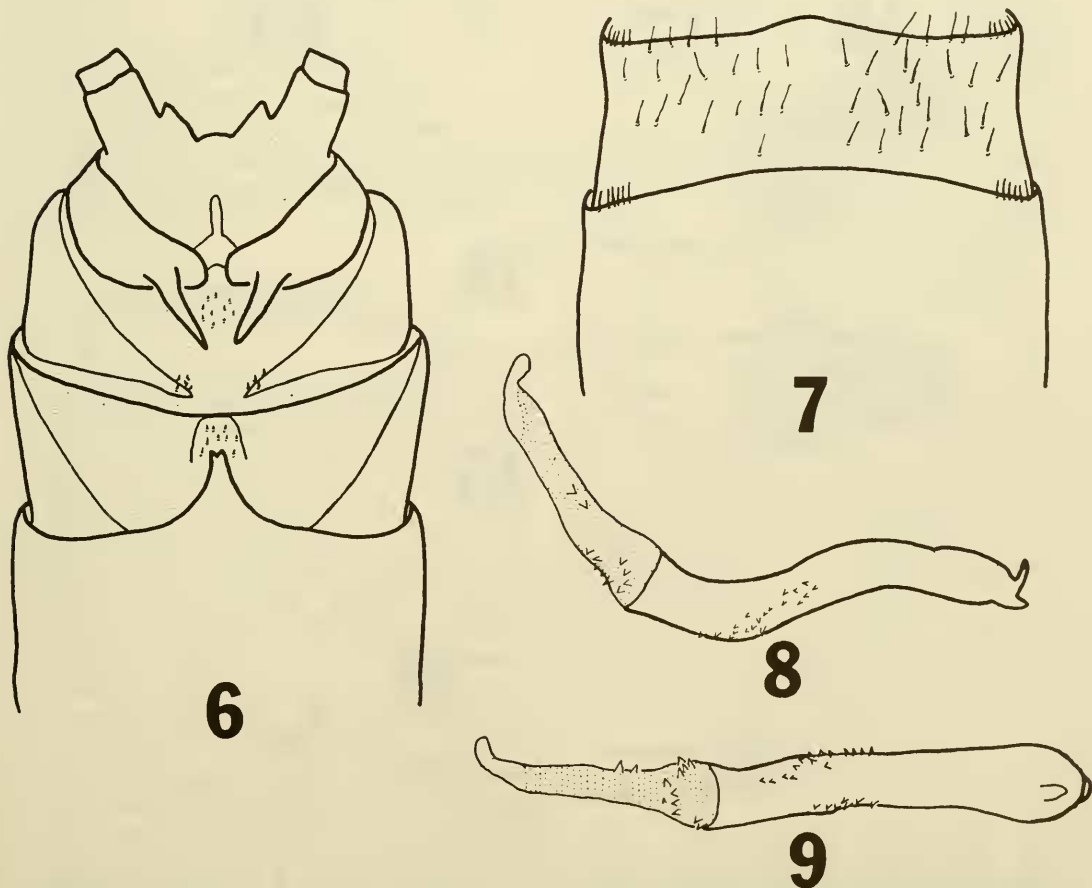
ETYMOLOGY.— This species is named for Dr. Mary Case Cather who collected the type series.

Neoperla choctaw, n. sp.

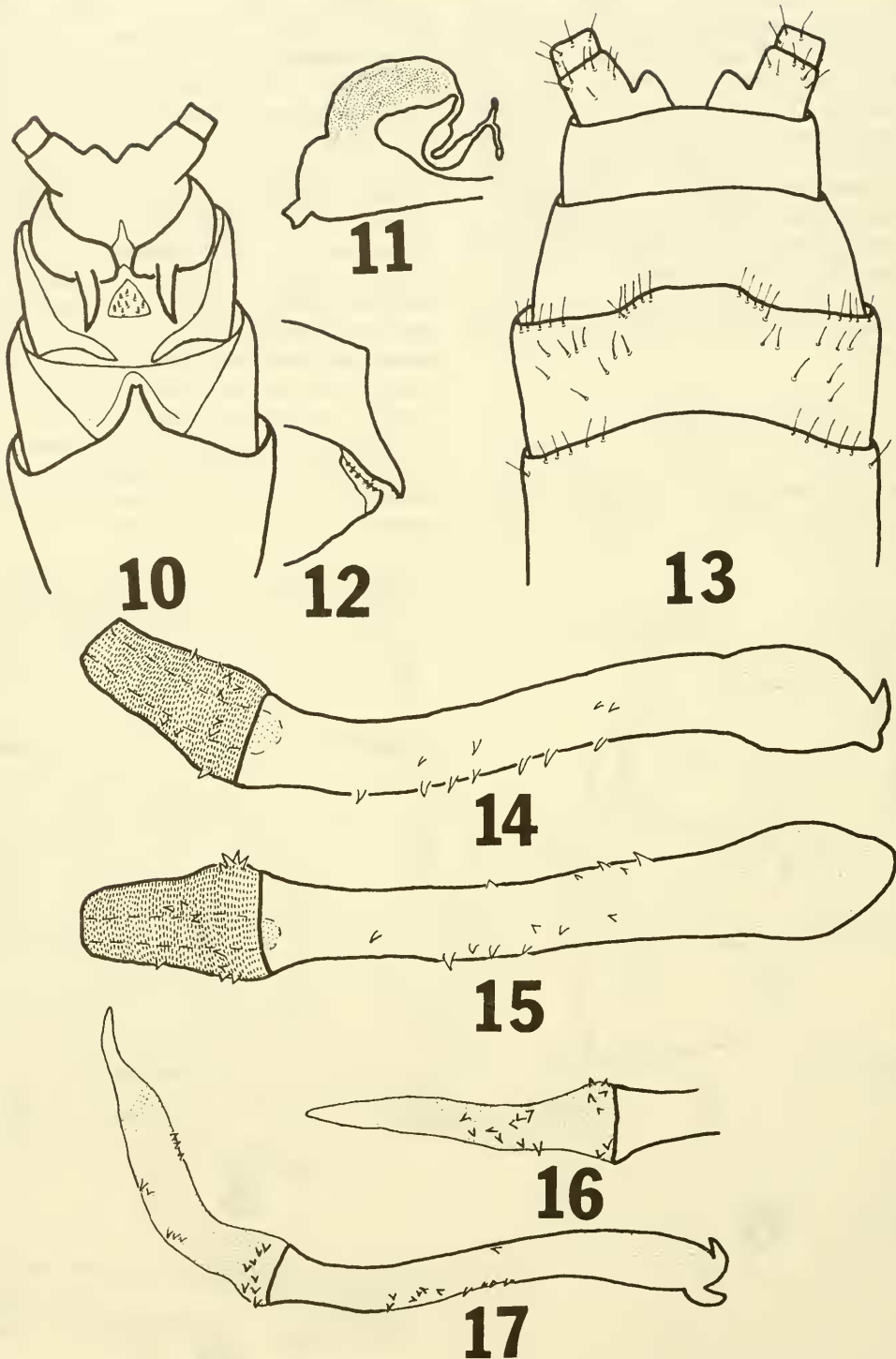
Figs. 10, 11, 12, 13, 14, 15, 16, 17, 67, 68

MALE.— Macropterous. Length of forewings 5-7 mm; length of body 5-7 mm.

Dorsum of head yellow, frons without brown markings. Pronotum brown with darker rugosities and sutures. Tibiae, tarsi, and femora dark brown with distal yellow bands on tibiae and proximal yellow bands on femora. Wings and veins brown; coastal margin pale yellow. Process of tergum 7 slender, ventrally spinulose, extending to near posterior margin of tergum 8. Process of tergum 8 abruptly elevated on posterior margin, slightly spinulose. Spinules absent from membrane of tergum 8. Mesal spinule patch of tergum 9 with 5-12 spinules, lateral patches with 0-3 spinules. Shaft of aedeagus with external spines arranged in two ventral groups; left grouping with 5-10 spines, right grouping with 3-7 spines. Extrusible, apical section of aedeagus heavily spiculate and armed with several scattered spines.



Figs. 6-9. *Neoperla catharæ*: 6, Male terminalia, dorsal; 7, Female sterna 7 and 8; 8, Aedeagus, lateral; 9, Aedeagus, ventral.



Figs. 10-17. *Neoperla choctaw*: 10, Male terminalia, dorsal; 11, Vagina, lateral; 12, Male terga 7 and 8, lateral; 13, Female terminalia, ventral; 14, Aedeagus, lateral; 15, Aedeagus, ventral; 16, Apical section of aedeagus, ventral; 17, Aedeagus, apical section extruded, lateral.

FEMALE.— Macropterous. Length of forewings 8–10 mm; length of body 8–10 mm. Color pattern similar to male. Subgenital plate slightly produced, posterior margin smoothly rounded to emarginate. Vagina without sclerites; spermatheca short and incompletely lined with golden-brown spinulae in basal half.

EGG.— Outline oval, cross section circular. Collar absent. Chorion finely punctate, with larger punctations mesally and finer punctations near polar ends.

TYPES.— Holotype (♂), allotype (♀), and 1 ♂ 3 ♀ paratypes from Red Oak Creek, Denman, Latimer Co., Oklahoma, 1-VII-1970, B. Stark. Holotype, # 73358, and allotype deposited at the U.S. National Museum. Paratypes: OKLAHOMA: *Latimer Co.*, Red Oak Creek, Denman, 1-2-VII-1975, B. Stark, 5 ♂ 12 ♀ (BPS) (NTSU); Turkey Creek, 6 mi E Red Oak, 2-VII-1975, B. Stark, 30 ♂ 47 ♀ (BPS) (NTSU) (INHS). WEST VIRGINIA: *Berkeley Co.*, Back Creek, 30-VII-1946, E. P. Merkel, 3 ♂ 1 ♀ (RWB) (USNM).

ETYMOLOGY.— This species was discovered in the former Choctaw portion of the Indian Territory and is named in honor of that tribe.

Neoperla freytagi, n. sp.
Figs. 18, 19, 20, 21, 22, 23, 58, 59

MALE.— Macropterous. Length of forewings 8–11 mm; length of body 7–10 mm. General color lemon yellow with dark brown markings. Dorsum of head with ocelli covered by a dark brown quadrangular area. Pronotum light brown with irregular darker rugosities; marginal and median sutures dark brown. Wings subhyaline, coastal margin yellow. Process of tergum 7 triangular, ventrally spinulose. Process of tergum 8 moundlike, smoothly rounded in profile and spinulose; membrane of tergum 8 with 0–2 spinules. Tergum 9 with a mesal and two lateral spinule patches; anterior margins of each spinule patch with a number of long setae. Shaft of aedeagus with a dense patch of spinules ventrally; external spines absent. Extrusible, apical section of aedeagus membranous, bearing a few small spines.

FEMALE.— Macropterous. Length of forewings 12–14 mm; length of body 12–14 mm. Color pattern similar to male. Subgenital plate slightly produced, posterior margin straight. Vagina with a pair of sclerites; spermatheca long, incompletely lined with golden-brown spinulae from near basal third to near apex.

EGG.— Outline oval, cross section circular. Collar with two rows of irregular reticulation. Chorion longitudinally striate with alternating nonpunctate, elevated bands and depressed finely punctate bands. Micropyles irregularly placed in depressed bands. Polar third of egg with irregular 4-, 5-, or 6-sided reticulation.

TYPES.— Holotype (♂), allotype (♀), and 7 ♂ 24 ♀ paratypes from Larue Co., Kentucky, 16-VI-1971, P. H. Freytag & G. Lepert. Holotype, # 73356, and allotype deposited at the U.S. National Museum. Paratypes: ARKANSAS: *Benton Co.*, 24-VI-1963, O. & M. Hite, 65 ♀ (INHS). NEW YORK: *Greene Co.*, East Durham, 26-VII-1971, S. E. Thewke, 2 ♂ 6 ♀ (MU) (BPS). *Tompkins Co.*, Ithaca, 21-30-VII-1929, 2 ♂ (BPS) (DC). OHIO: *Warren Co.*, Little Miami River, Loveland, 2-VII-1953, A. R. Gaufin, 1 ♀ (RWB). ONTARIO: *Peel Co.*, Streetsville, 29-VIII-1952, G. B. Wiggins, 2 ♀ (ROM); Churchville, Credit River, 14-VII-1952, G. B. Wiggins, 2 ♀ (ROM); Erindale, Credit River, 16-VI-1952, G. B. Wiggins, 7 ♂ 2 ♀ (ROM). *Halton Co.*, Norval, Credit River, 14-VII-1952, G. B. Wiggins, 2 ♂ (ROM). SOUTH CAROLINA: *Oconee Co.*, Brasstown, 29-VI-1969, H. Douglass, 1 ♀ (BPS). *Pickens Co.*, Wildcat Creek, 25-VI/22-VII-1968, P. Carlson, 31 ♂ 18 ♀ (PHC) (BPS) (NTSU). TENNESSEE: *Sevier Co.*, Gatlinburg, 13-19-VI-1942, N. Dybas, 1 ♂ 4 ♀ (FMNH).

ETYMOLOGY.— This species is named for Dr. Paul Freytag who collected the type series.

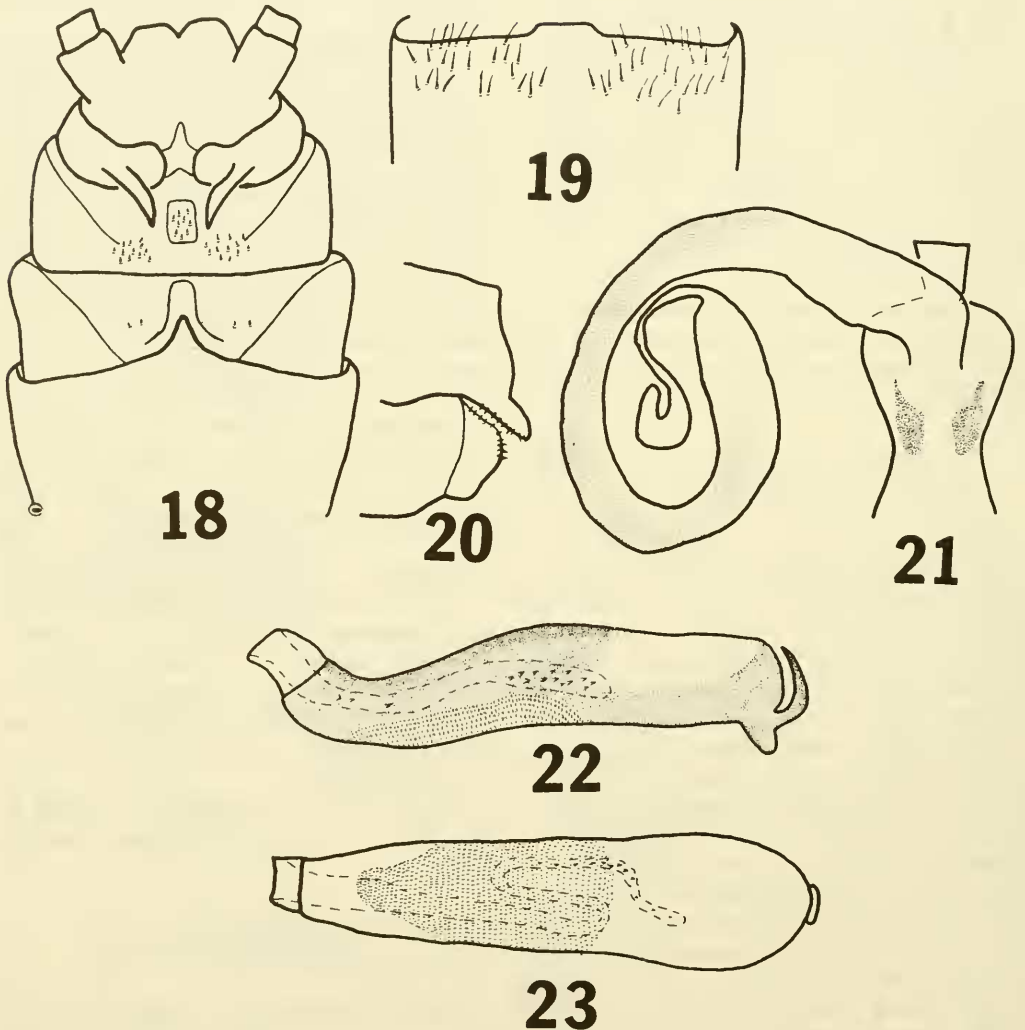
Neoperla gaufini, n. sp.
Figs. 24, 25, 26, 27, 28, 69, 70

MALE.— Macropterous. Length of forewings 6–8 mm; length of body 6–8 mm. Dorsum of head yellow with brown markings on occiput, between ocelli and on lat-

eral margins of frons. Pronotum brown with darker rugosities and sutures. Tibiae, tarsi, and femora dark brown with distal yellow bands on tibiae and proximal yellow bands on femora. Wings and veins brown, coastal margin pale yellow. Process of tergum 7 slender, ventrally spinulose, extending to apical third of tergum 8. Process of tergum 8 abruptly elevated on posterior margin, slightly spinulose. Spinules absent from membrane of tergum 8. Mesal spinule patch of tergum 9 with 5-12 spinules, lateral patches with 3-6 scattered spinules. Shaft of

aedeagus with external spines arranged in two ventral groups; left grouping with 2-6 spines, right grouping with 6-10 spines. Extrusible, apical section heavily spiculate and armed with several scattered spines.

FEMALE.— Macropterous. Length of forewings 7-9 mm; length of body 7-9 mm. Color pattern similar to male. Subgenital plate slightly produced, posterior margin smoothly rounded to emarginate. Vagina without sclerites; spermatheca short and completely lined with golden-brown spinulae in basal half.

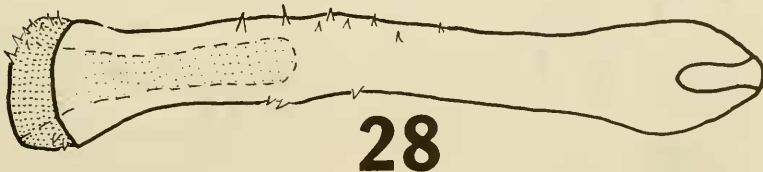
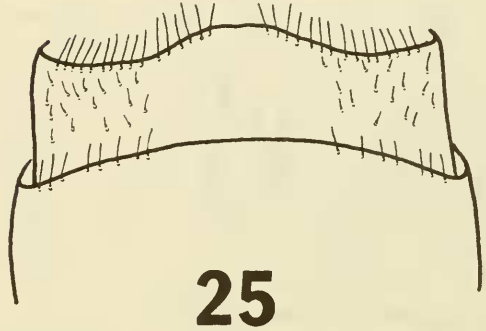
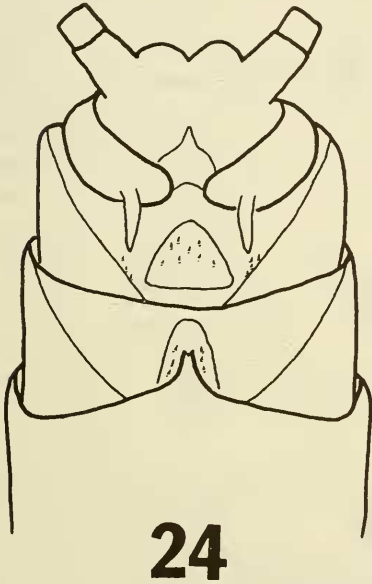


Figs. 18-23. *Neoperla freytagi*: 18, Male terminalia, dorsal; 19, Female sternum 8; 20, Male terga 7 and 8, lateral; 21, Vagina, dorsal; 22, Aedeagus, lateral; 23, Aedeagus, ventral.

EGG.—Outline oval, cross section circular. Collar absent. Chorion covered with large regular depressions.

TYPES.—Holotype (♂), allotype (♀), and 1 ♂ 6 ♀ paratypes from Little Miami River, Morrow, Warren Co., Ohio, 26-VI-1952, A. R. Gaufin. Holotype, # 73354, and allotype deposited at the U.S. National Mu-

seum. Paratypes: INDIANA: *Jefferson Co.*, Clifty Falls State Park, 18-VII-1972, A. Provonsha & E. Levine, 1 ♀ (PU). KENTUCKY: *Shelby Co.*, Brashears Creek, 3-VIII-1972, D. White, 1 ♀ (BPS). *Spencer Co.*, Salt River, 25-26-VI-1971, V. Resh & D. White, 1 ♂ 1 ♀ (BPS). OHIO: *Clinton Co.*, Cowan Creek, 5-VI-1951, A. R. Gaufin,



Figs. 24-28. *Neoperla gaufini*: 24, Male terminalia, dorsal; 25, Female sterna 7 and 8; 26, Vagina, lateral; 27, Aedeagus, lateral; 28, Aedeagus, ventral.

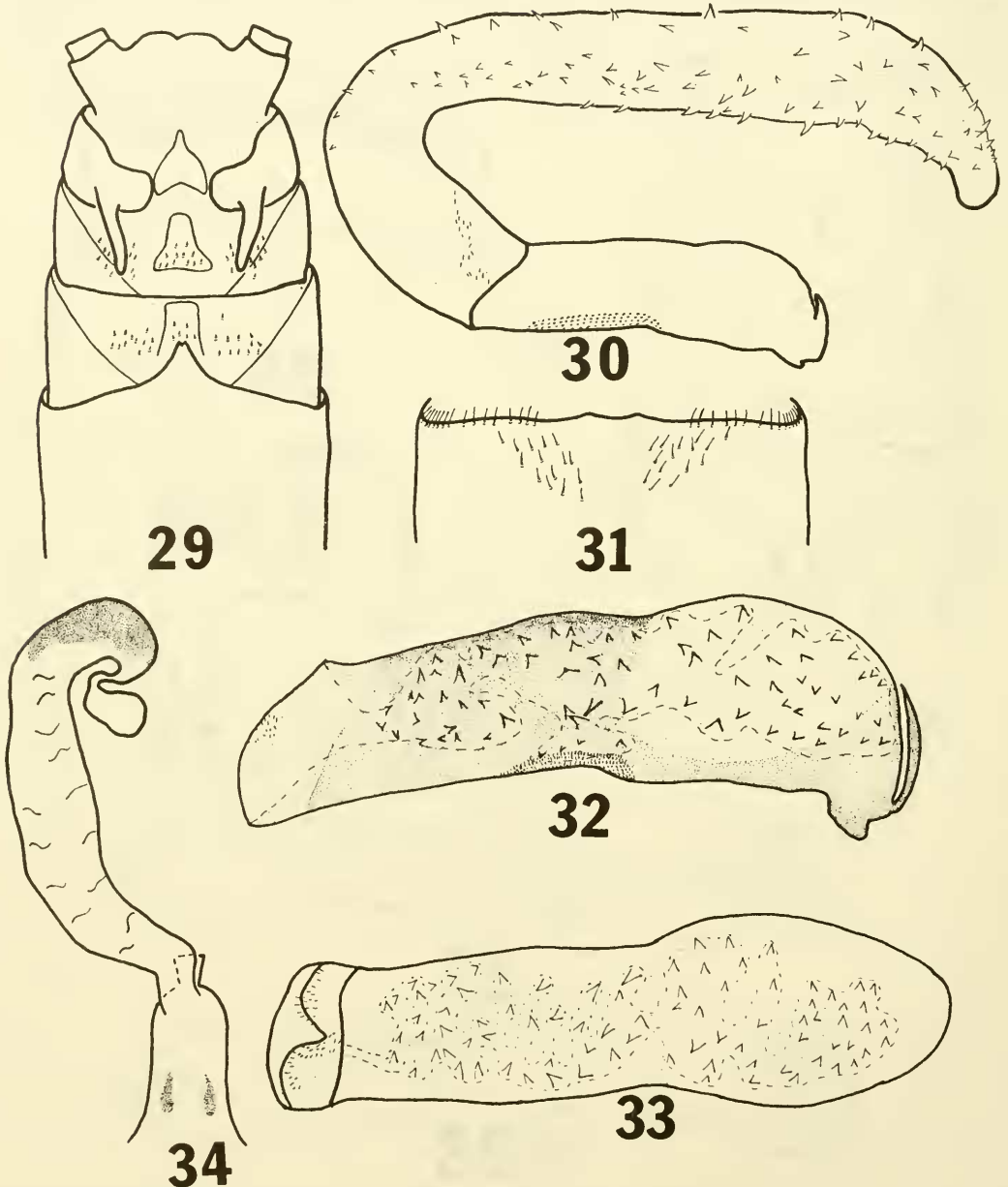
9 ♂ 17 ♀ (UU) (BPS) (NTSU). Warren Co., Little Miami River, Loveland, 2-VII-1953, A. R. Gaufin, 5 ♂ 10 ♀ (RWB) (USNM).

ETYMOLOGY.—This species is named in honor of Dr. A. R. Gaufin who collected it and labeled it "*Neoperla* n. sp." in the early 1950s.

Neoperla stewarti, n. sp.

Figs. 29, 30, 31, 32, 33, 34, 63

MALE.—Macropterous. Length of forewings 9–11 mm; length of body 9–11 mm. Dorsum of head yellow with diffuse brown markings on anterior region of frons; ocellar area dark brown. Pronotum brown with



Figs. 29–34. *Neoperla stewarti*: 29, Male terminalia, dorsal; 30, Aedeagus, apical section extruded, lateral; 31, Female sternum 8; 32, Aedeagus, lateral; 33, Aedeagus, ventral; 34, Vagina, dorsal.

darker rugosities and sutures. Dorsum of tibiae and femora brown becoming lighter on ventral surface and apically; tarsi dark brown. Process of tergum 7 triangular, ventrally spinulose, extending to near middle of tergum 8. Process of tergum 8 moundlike, smoothly rounded in lateral view and spinulose; membrane of tergum 8 with 5 or more spinules on each side of process. Tergum 9 with a mesal and 2 lateral spinule patches; anterior margins of each spinule patch with a number of long setae. Shaft of aedeagus with a small dense pad of spinules ventrally; external spines absent. Extrusible, apical section of aedeagus membranous, heavily armed with large spines and a basal group of small spinules.

FEMALE.— Macropterous. Length of forewings 11–13 mm; length of body 10–12 mm. Color pattern similar to male. Subgenital plate slightly produced, or unproduced. Vagina with paired sclerites; spermatheca long and lined with golden-brown spinulae in apical third.

EGG.— Outline oval, cross section circular. Collar with a single irregular row of reticulation. Chorion longitudinally striate with alternating nonpunctate, elevated bands and depressed finely punctate bands. Some elevated bands branch near midline. Micropyles irregularly placed in depressed bands. Polar third of egg with irregular 4-, 5-, or 6-sided reticulation.

TYPES.— Holotype (♂), allotype (♀), and 22 ♂ 3 ♀ paratypes from Larue Co., Kentucky, 16-VI-1971, P. H. Freytag & G. Lepert. Holotype, # 73353, and allotype deposited at the U.S. National Museum. Paratypes: ARKANSAS: *Washington Co.*, White River, rt. 68, 4-VI-1963, L. O. Warren, 2 ♂ 11 ♀ (RWB) (USNM). MISSISSIPPI: *Lauderdale Co.*, Meridian, 1-VI-1968, B. Stark, 1 ♂ (BPS). OHIO: *Hocking Co.*, 18-VI-1938, E. S. Thomas, 1 ♂ (UU). *Jackson Co.*, 11-VI-1933, D. Smith, et al., 1 ♂ (UU); Washington Township, 6-VII-1935, E. S. & J. H. Thomas, 1 ♂ (UU). *Warren Co.*, Morrow, 23-26-VI-1952, A. R. Gaufin, 10 ♂ 21 ♀ (UU) (BPS); Todd Fork, 19-VI-1952, A. R. Gaufin, 3 ♂ 34 ♀ (UU) (BPS); same data, 11-VII-1953, 1 ♂ 7 ♀ (UU). WISCONSIN: *Douglas Co.*, St. Croix River,

Dairyland, 20-VII-1967, A. Lemke, 1 ♂ (BPS).

ETYMOLOGY.— This species is named in honor of Dr. K. W. Stewart who introduced the senior author to Plecoptera.

Neoperla mainensis Banks, new status
Figs. 35, 36, 37, 38, 60, 61, 62

Neoperla clymene mainensis Banks, 1948: 124. Holotype ♂; Rome, Maine (MCZ # 27725).

MALE.— Macropterous. Length of forewings 7–10 mm; length of body 7–10 mm. Dorsum of head diffuse brown to black, yellow around margins. Pronotum brown with darker rugosities and sutures. Tibiae, tarsi, and femora brown. Wings and veins brown, coastal margin pale yellow. Process of tergum 7 short, broadly triangular and spinulose ventrally. Process of tergum 8 moundlike, smoothly rounded in lateral view and spinulose; membrane of tergum 8 with numerous spinules on both sides of process. Tergum 9 with a mesal and 2 lateral spinule patches; anterior margins of each spinule patch with a number of long setae. Shaft of aedeagus abruptly bent near apex and with ventral and dorsal patches of spinules; external spines absent. Extrusible, apical section of aedeagus membranous, bearing many small spines.

FEMALE.— Macropterous. Length of forewings 10–12 mm; length of body 10–12 mm. Color pattern similar to male. Subgenital plate moderately produced, triangular in outline and apically notched. Vagina with a pair of sclerites; spermatheca long, incompletely lined in apical half with golden-brown spinulae.

EGG.— Outline oval, cross section circular. Collar distinct, with two or three rows of irregular reticulation. Chorion longitudinally striate with alternating nonpunctate, elevated bands and depressed finely punctate bands; two elevated bands arising from a single reticulation point at collar join different reticulation points at polar end. Polar third of egg with irregular 4-, 5-, or 6-sided reticulation.

SPECIMENS EXAMINED.— MAINE: *Kennebec Co.*, Rome, 26-VI/8-VII-1944, A. Lovelidge, 6 ♂ 1 ♀ (Type series, MCZ). OHIO: Put-in-Bay, 22-VI-1920, 11 ♂ 3 ♀ (UU) (BPS).

Neoperla clymene (Newman)

Figs. 39, 40, 41, 42, 43, 44, 45, 56, 57

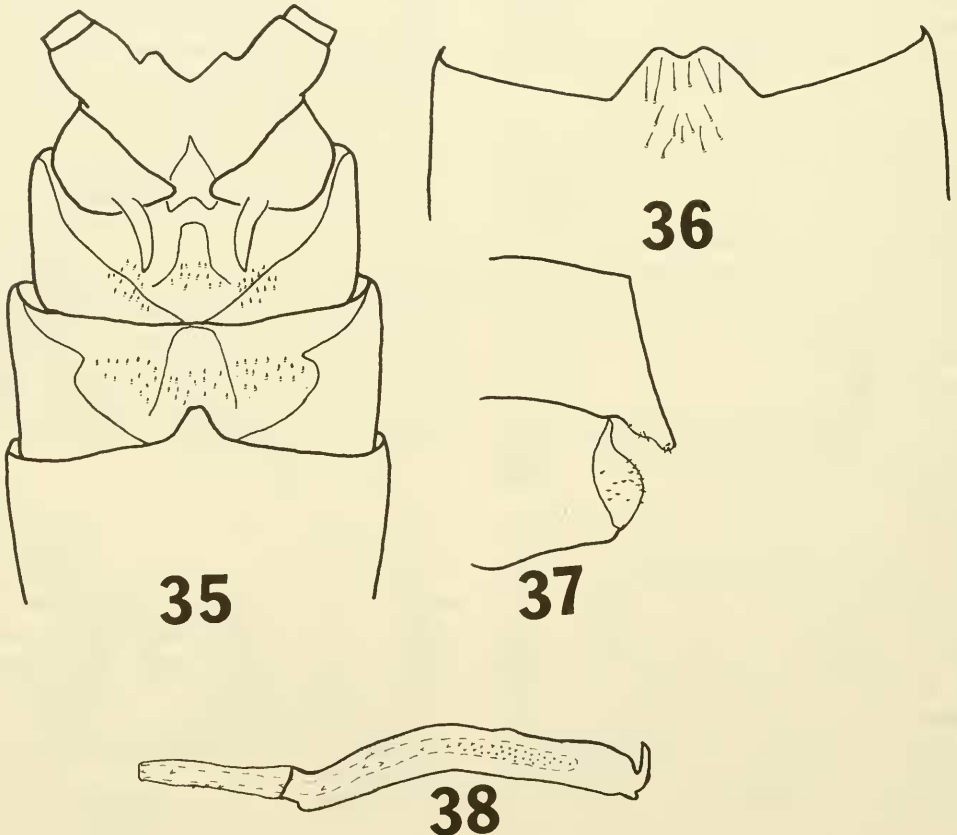
Chloroperla clymene Newman, 1839: 87. Holotype ♀; Georgia (BMNH).*Perla occipitalis* Pictet, 1841: 254. Syn. Needham & Claassen, 1925.

MALE.— Macropterous. Length of forewings 9–12 mm; length of body 8–11 mm. Dorsum of head yellow with diffuse brown markings around anterior margin of frons; ocellar area with or without brown pigmentation. Pronotum brown with darker rugosities and sutures, a narrow pale stripe extending along median suture. Wings subhyaline, veins brown; coastal margin pale yellow. Tibiae, tarsi, and femora brown. Process of tergum 7 short, triangular, and ventrally spinulose. Process of tergum 8 moundlike, smoothly rounded in lateral view and spinulose; membrane of

tergum 8 without spinules. Tergum 9 with a mesal and 2 lateral spinule patches; anterior margins of spinule patches with long setae. Shaft of aedeagus without spinulae or spines. Extrusible, apical section of aedeagus membranous, bearing many spines.

FEMALE.— Macropterous. Length of forewings 13–15 mm; length of body 12–15 mm. Color pattern similar to male. Subgenital plate unproduced. Vagina with a pair of sclerites; spermatheca long, incompletely lined apically with golden-brown spinules.

EGG.— Outline oval, cross section circular. Collar with two irregular rows of reticulation. Chorion longitudinally striate with alternating nonpunctate, elevated bands and depressed, finely punctate bands. Micropyles irregularly placed in depressed bands. Polar



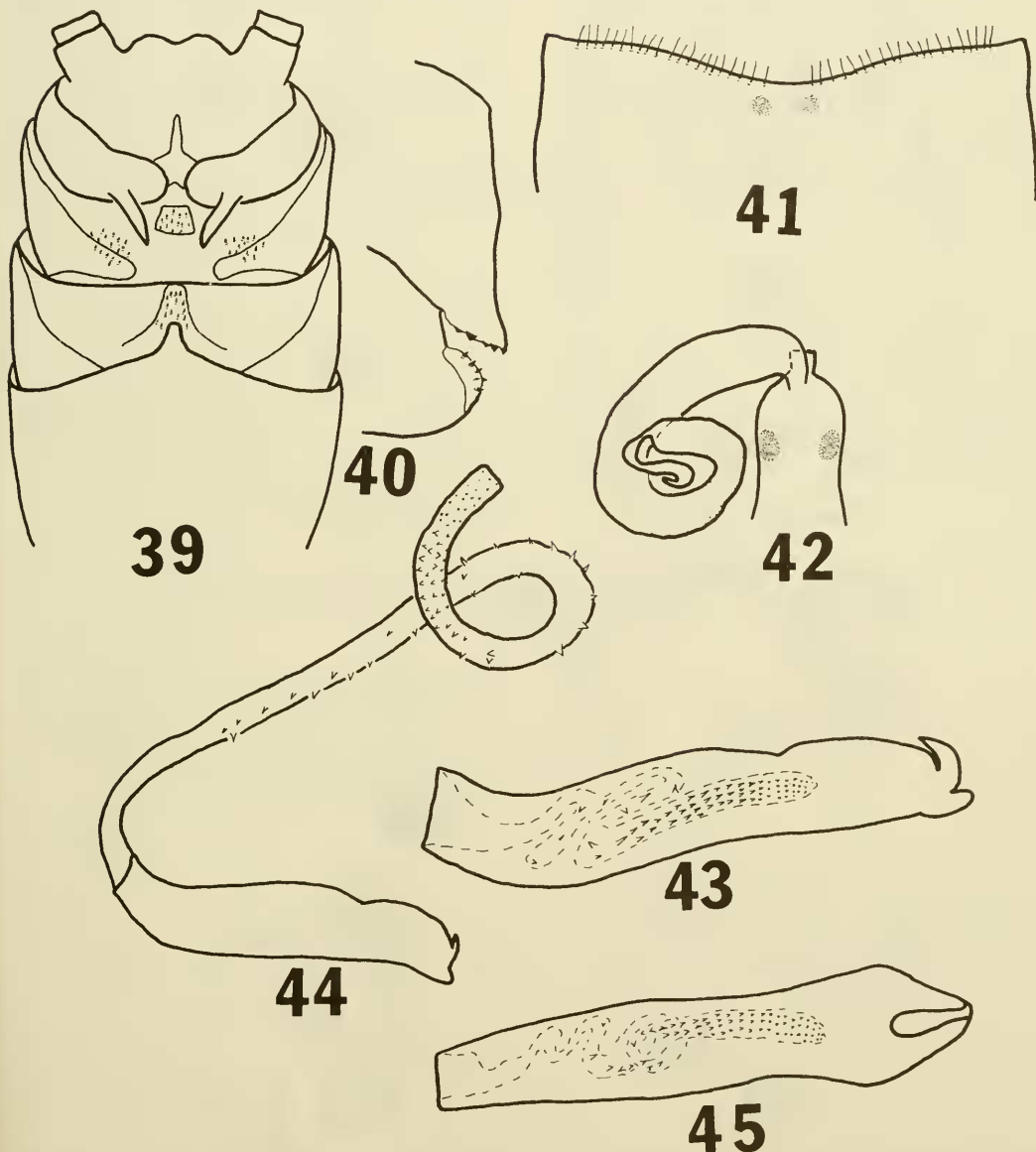
Figs. 35–38. *Neoperla mainensis*: 35, Male terminalia, dorsal; 36, Female sternum 8; 37, Male terga 7 and 8, lateral; 38, Aedeagus, lateral.

third of egg with irregular 4-, 5-, or 6-sided reticulation.

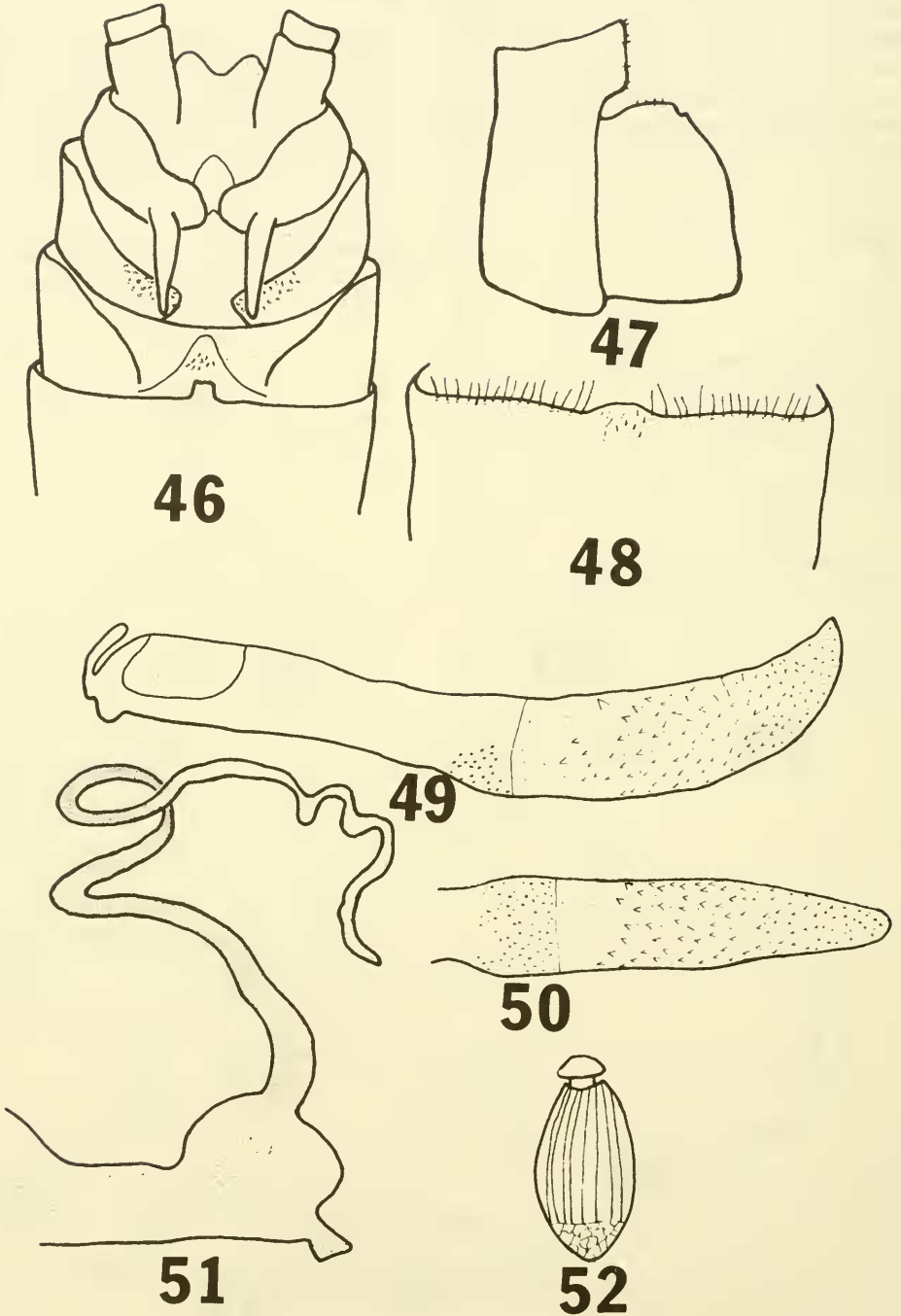
SPECIMENS EXAMINED.—ALABAMA: Escambia Co., Tuscaloosa Co. FLORIDA: Gadsden Co., Liberty Co., Okaloosa Co., Putnam Co. GEORGIA: Appling Co., Burke Co. LOUISIANA: East Baton Rouge Par., Livingston Par., St. Tammany Par. MISSISSIPPI: Oktibbeha Co. NEW YORK:

Tompkins Co. OKLAHOMA: Adair Co., Bryan Co., Cherokee Co. TEXAS: Bell Co., Dewitt Co., Nacogdoches Co., Palo Pinto Co.

DISCUSSION.—Nearctic *Neoperla* fall readily into two species complexes. The first of these, the *choctaw* group (*choctaw*, *catharae*, *carlsoni*, *gaufini*), includes species whose males have external spines on the ae-



Figs. 39-45. *Neoperla clymene*: 39, Male terminalia, dorsal; 40, Male terga 7 and 8, lateral; 41, Female sternum 8; 42, Vagina, dorsal; 43, Aedeagus, lateral; 44, Aedeagus, apical section extruded, lateral; 45, Aedeagus, ventral.



Figs. 46-52. *Neoperla* sp., Gold Coast, Africa: 46, Male, terminalia, dorsal; 47, Male, terga 7 and 8, lateral; 48, Female sternum 8; 49, Aedeagus, lateral; 50, Aedeagus, ventral; 51, Vagina, lateral; 52, Egg.

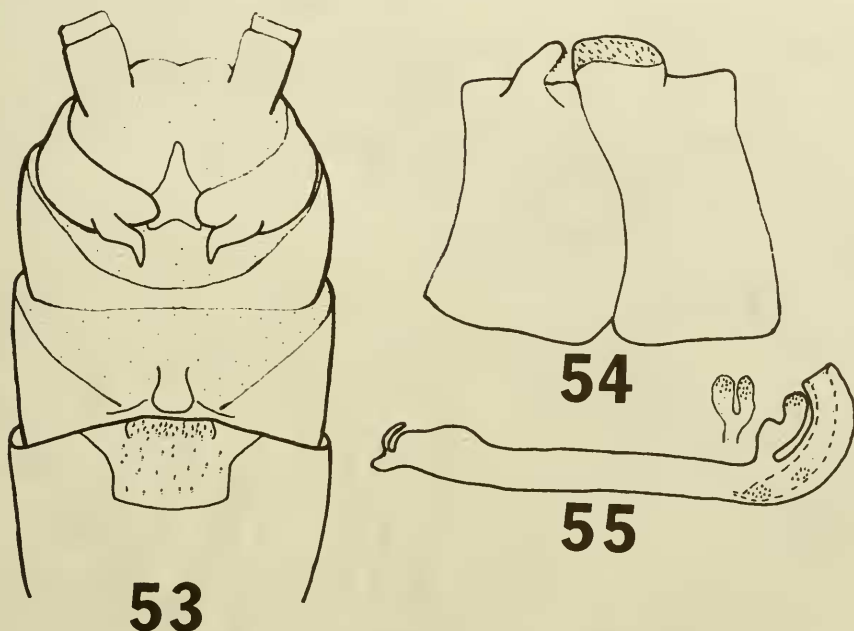
deagal shaft and a spiculate apical section of the aedeagus. Females have a short spermatheca lined basally with spinulae, lack vaginal sclerites, and have nonstriate chorionic reticulation of the ova. Previous studies of exotic *Neoperla* (Hynes 1952, Kawai 1967, Wu 1938, Zwick 1972, 1973a,b) have not included species which are conclusively of this group, although Zwick's (1973b) *Neoperla* sp. 11 from Ghana appears similar in egg and vaginal characters to *catharae*.

The *clymene* group (*clymene*, *freytagi*, *mainensis*, *stewarti*) includes species whose males lack external spines or spiny lobes on the aedeagal shaft but have the membranous apical section covered irregularly with spines. The process of tergum 7 is short and triangular and the process of tergum 8 is moundlike, small, and covered with spinules. Females have a long spermatheca irregularly lined with spinulae, vaginal sclerites are generally present, and the egg is striate. As Zwick (1973b) noted, this is a large, widespread group occurring in Africa, Asia, and North America. Figures

46-52 show details of an undetermined member of this group from Gold Coast, Africa.

The species *N. hubbsi* Ricker is allied to another group which includes *N. geniculata* (Pictet) and *N. nipponensis* (McLachlan). This group is distinguished primarily by modifications of the processes on terga 7 and 8, and many species have prominent spiny lobes on the aedeagal shaft. Data on female genitalia and egg morphology are unavailable. Figures 53-55 show details of an undetermined member of this group from Thailand. We are convinced on the basis of personal collecting at the supposed type locality and from correspondence with museum personnel at the University of Michigan that the holotype specimen of *hubbsi* came from the Eastern Hemisphere rather than from Kansas.

Within each group, Nearctic species are most easily diagnosed on the basis of aedeagal, vaginal, and egg characters. *Neoperla carlsoni* (25-35 spines), and *choctaw* (5-10 spines) have the greatest concentrations of external spines on the left side of

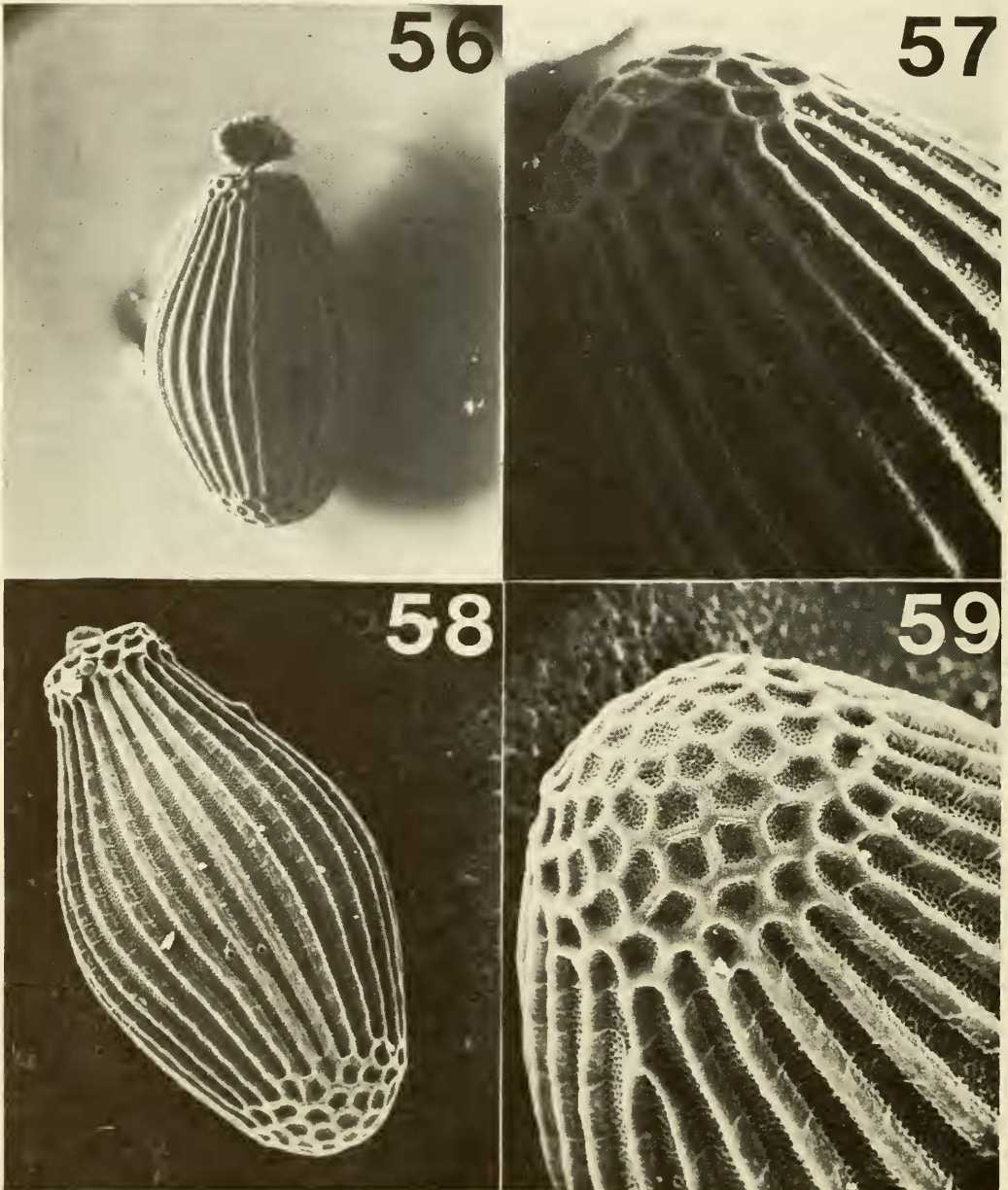


Figs. 53-55. *Neoperla* sp., Thailand: 53, Male terminalia, dorsal; 54, Male, terga 7 and 8, lateral; 55, Aedeagus, lateral.

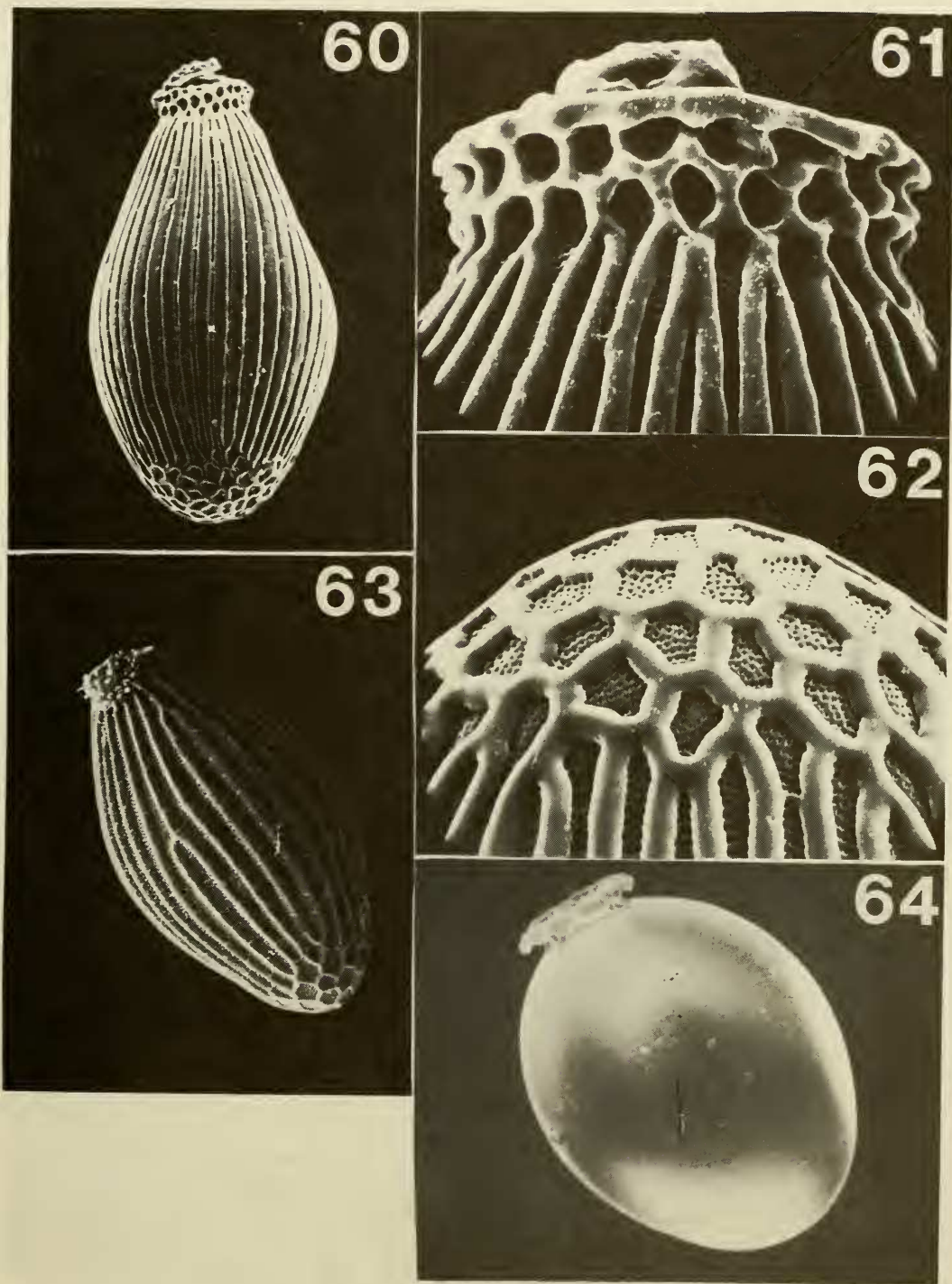
the aedeagal shaft (ventral view), and *catharac* (12–20 spines) and *gaufini* (6–10 spines) have the greatest number of spines on the right side of the aedeagal shaft. Females are easily distinguished by details of chorionic reticulation (Figs. 64–70).

In the *clymene* group, *mainensis* is distin-

guished by the long, apically notched female subgenital plate and the apical bend of the aedeagal shaft. Externally, *mainensis* and *stewarti* males have large patches of spinules on the membrane of tergum 8, but size, shape, and arrangement of spines on the aedeagus is distinctive. Males of *cly-*



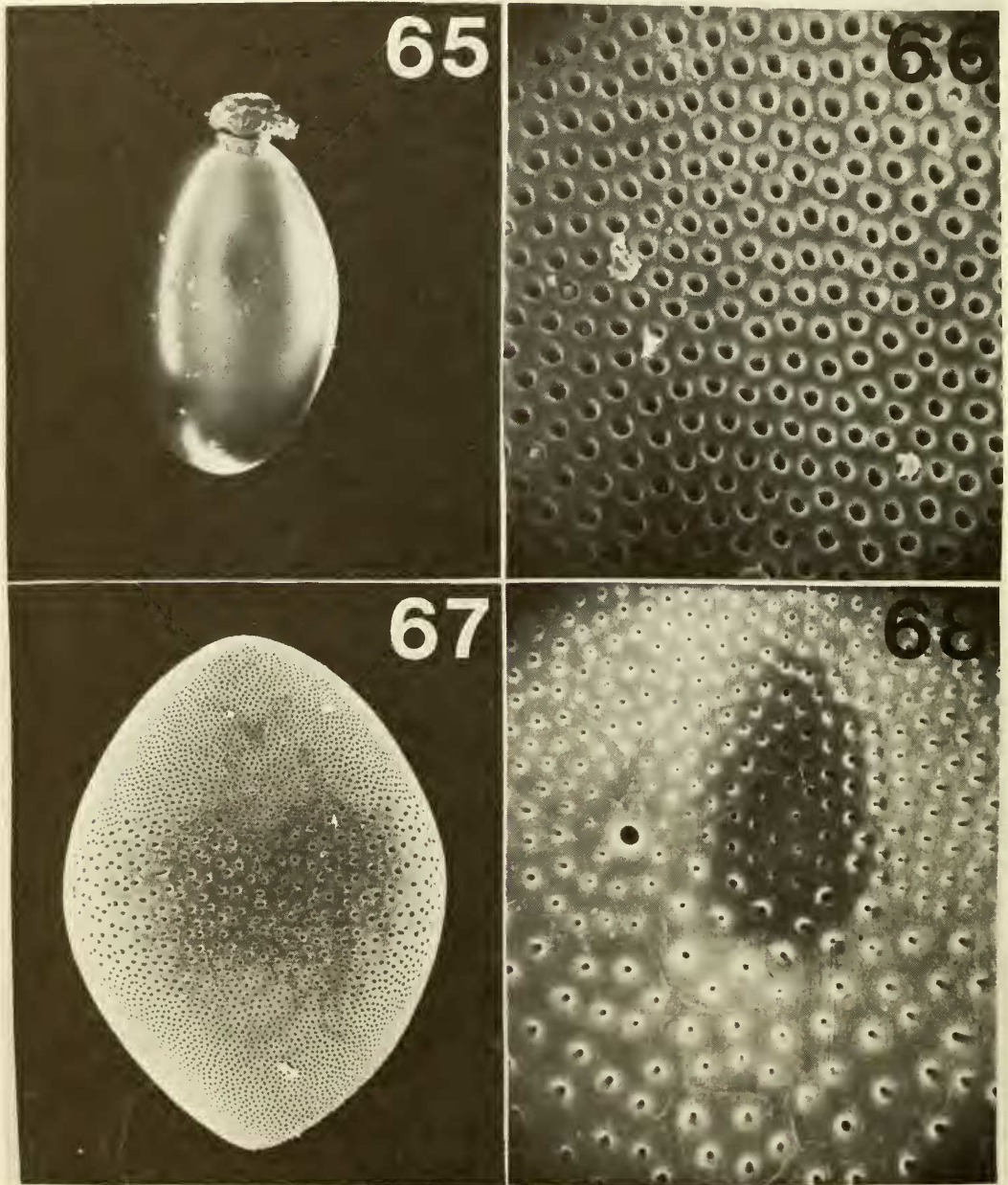
Figs. 56–59. SEM micrographs of eggs: 56, *Neoperla clymene*, 200x; 57, *N. clymene*, detail of polar end 500x; 58, *N. freytagi*, 260x; 59, *N. freytagi*, detail of polar end, 560x.



Figs. 60-64. SEM micrographs of eggs: 60, *Neoperla mainensis*, 215x; 61, *N. mainensis*, detail of collar, 1050x; 62, *N. mainensis*, detail of polar end, 1050x; 63, *N. stewarti*, 260x; 64, *N. catharæ*, 400x.

mene and *freytagi* are externally similar, both having few or entirely lacking spinules on the membrane of tergum 8, but are separable by the absence of spinules on the aedeagal shaft in *clymene* and by the smaller

number of spines of the apical aedeagal section in *freytagi*. Females are distinguished by the outline of subgenital plate, by the extent of spinulae in the spermatheca and by details of egg morphology (Figs. 56-63).



Figs. 65-68. SEM micrographs of eggs: 65, *Neoperla carlsoni*, 200x; 66, *N. carlsoni*, detail of chorion, 2000x; 67, *N. choctaw*, 200x; 68, *N. choctaw*, detail of chorion, 1000x.

ACKNOWLEDGMENTS

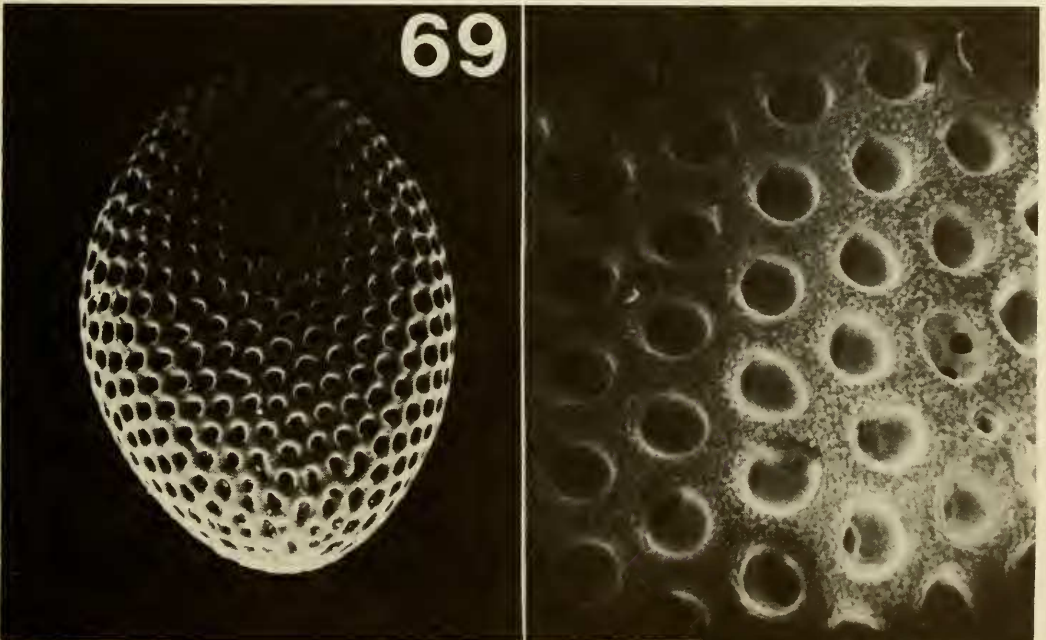
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Abbreviations for collections of the authors are BPS and RWB, respectively.

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Figs. 69-70. SEM micrographs of eggs: 69, *Neoperla gausfini*, 280x; 70, *N. gausfini*, detail of chorion, 1000x.

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